Method and device for the control of a rotary tablet forming machine

This non-provisional application claims priority under 35 U.S.C. § 119(a) on Patent Application No. 03090036.9 filed in Europe on February 10, 2003, the entire contents of which are hereby incorporated by reference.

Field of the Invention

The invention concerns a method and a device for the control of a rotary tablet forming machine where a rotor is capable of being rotated by means of a drive unit, the rotor including at least one matrix with allocated upper punches and lower punches and a pressing force, acting on the press mass filled into the one matrix at least, is determined.

Description of the Background Art

Rotary tablet forming machines of the category-related type are known. A typical factor here is that, upon starting the drive unit, the rotor is brought from standstill position to its rated speed. By way of at least one filling shoe, the matrixes are filled with the press mass and, depending on the angular position of the rotor, the lower and the upper punches which are guided by guide curves are moved axially to the matrixes. The upper and lower punches are directed past at least one press station, normally a pre-press station and a main press station. At that location, the upper and lower punches are directed past stationary arranged press rollers, essentially tangential, so that a pressing force can be applied onto the press mass filled into the matrixes.

Setting and measuring the pressing force is known, for example from EP 0 698 481 B1. In this case, there is an essential correlation between the measured maximum pressing force and the mass of the press mass filled into the matrixes under the prerequisite of the same material properties of the press mass. There is, in this case, a direct correlation between the tablet weight and the pressing force required for the manufacture of the tablets. In dependence on the material to be pressed, a certain pressing force is allocated to each tablet weight with a tablet form pre-specified by the press tools and a set tablet

height. If the filling volume, and subsequently the tablet weight, fluctuates at a constant tablet height, a pressing force change results therefrom in direct dependence.

If all matrixes in a rotary tablet forming machine are normally filled with press mass up to the press station (meaning, up to the pressure roller), pressure rollers and rotor during start-up are accelerated to the rated speed in the same time period. This is attributable to the fact that each punch, as a result of the rotational movement of the rotor, is drawn past under the pressure roller - touching this – and her via the rotation of the punches the acceleration of the pressure roller is effected so that the acceleration of the pressure roller is directly dependent on the rotational speed of the punches.

This correlation between acceleration of the rotor and acceleration of the pressure rollers is then disadvantageous if, upon rotation of the rotor, the matrixes arriving at the press station (pressure rollers) are not or are only partially filled with press mass.

This can be the case, for example, during the start-up of the rotary tablet forming machine after cleaning or in the event of an interruption of the material feed by way of the filling shoe(s) with press mass.

If the rotary tablet forming machine is now started up with non-filled or with only partially filled matrixes, the upper and lower punches in the press station do not touch or only partially touch the pressure rollers. By starting up the drive unit the rotor with the punch is, however, accelerated to its rated speed. If a first punch with a first orderly filled matrix now accesses the press station, the punch or the punch couple, corresponding to the rotor already accelerated to rated speed, hits the pressure roller which is not yet or only insufficiently accelerated. In this case, the punch has an abrupt impact on the pressure roller so that suddenly a high kinetic energy has to be absorbed by the pressure roller and the punches involved. This can lead to damage of the pressure rollers and/or the punches.

Brief Summary of the Invention

The invention is therefore based on the task assignment of creating a method and a device of the category-related type, by means of which such damage can be avoided.

Because of the fact that the determined pressing force is compared with a pre-specifiable limit value and, if a rate drops below the limit value, the required speed of the rotor is reduced to a speed below the rated speed, it is advantageously possible to synchronise the acceleration of the rotor and the acceleration of the pressure rollers in every operating situation to their rated speeds. In this way it is particularly avoided that the rotor is accelerated to its rated speed before the pressure rollers. Subsequently, an abrupt impact of the punches onto the pressure rollers is avoided and, with this, the damage possibilities existing with the state of the art of pressure rollers and/or punches are also avoided.

In a preferred embodiment of the invention, it is envisaged that the speed of the rotor is speed-controlled from its standstill position or its rated speed. In this way, the avoidance of the above-mentioned damage in every operating situation of the rotary tablet forming machine is possible.

Because of the fact that the rotary tablet forming machine includes a control device or similar for activating a drive unit of a rotor of the rotary tablet forming machine, a device for determining a pressing force as well as a means for comparing the determined pressing force with a pre-specifiable pressing force and at least one means for pre-specifying a required speed of the rotor in dependence of the comparison of the determined pressing force with the pre-specifiable pressing force, it is advantageously possible to implement in an uncomplicated manner. The control function in the rotary tablet forming machine which, depending on a filling degree of matrixes of the rotor, controls a required speed of the rotor. In this way a run-up, in particular, of the rotor adapted to the filling degree of the matrixes is made possible so that, in particular, mechanical loading/stressing/damage of pressure rollers and/or press punches can be avoided.

Further scope of the applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

Brief Description of the Drawings

The invention is explained as follows in greater detail with an embodiment as based on the relevant drawings, which are given by way of illustration only, and thus are not limitative of the present invention. The figures show the following:

Figure 1: a partially schematic illustration of a rotary tablet forming machine;

Figure 2: a block diagram of a device for the control of the rotary tablet forming machine, and

Figure 3: a control sequence.

Detailed Description of the Invention

Rotary tablet forming machines of the type referred to here are generally known. Within the framework of this description, therefore, more detailed attention is not given for the fundamental structural arrangement and basic functions.

Figure 1 shows in a schematic partial view the configuration of a rotor 12 of a rotary tablet forming machine with an overall designation 10. The rotor 12 has a large number of spaced matrixes 14 around its periphery. To each matrix 14 there is allocated a lower punch 16 and an upper punch 18 which are guided by guide curves 20 and 22, respectively, indicated here. Rotor 12 and lower punch 16 as well as upper punch 18 here

have a synchronous rotation around the rotating axis of the rotor 12. The rotor 12 can be rotated by an electric drive unit 24 which is only indicated here.

A press mass 26, which is only indicated here, is filled into the matrixes 14 by way of a filling facility, a so-called fill-in shoe. In the normal operating mode of the rotary tablet forming machine 10, the press mass 26 is filled in over the entire height of the matrix 14. The filling height can, for example, be defined by the height location of the lower punch 16 at a wiping station not shown here. In the example as illustrated, a non-normal filling is assumed. The press mass 26 is filled into the matrixes 14 only up to a partial height. It is also conceivable that absolutely no press mass 26 is filled into the matrixes 14 – for the non-normal case assumed here. Such circumstances could occur, for example, with a new startup of the rotary tablet forming machine 10 after a cleaning operation, maintenance or similar, or after an interruption of the stock feed of the press mass 26 by way of the filling facility.

In accordance with the course of the guide curves 20 and 22, the lower punches 16 and the upper punches 18 plunge into the matrix 14 and press the press mass 26 to the required tablet or similar.

For this purpose, the lower punches 16 and the upper punches 18 are directed past at least one pressing station 28 which envelops fixed-positioned pressure rollers 30. The pressure rollers 30 are individually trunnion-mounted around a rotating axis 32. The spacing of the pressure rollers 30 to one another is defined and ultimately determines the height of the tablet to be pressed. A drive of the pressure rollers 30 in arrow direction 34 - the upper pressure roller 30 anti-clockwise, the lower pressure roller clockwise – is effected by a passing movement of the lower punches 16 and upper punches 18, respectively, according to the movement direction 36 of the rotor 12. The lower punches 16 and the upper punches 18, respectively, come into a surface-to-surface contact with the peripheral surface 38 of the pressure rollers 30 and cause these rollers to rotate, practically carried along. The rotor 12 rotates here at a speed of n_r whereas the pressure rollers 30 rotate at a speed of n_d .

As a result of the non-filled or only partially filled matrixes 14, the press mass 26 to be pressed has only an inadequate counter force opposite the punches 16 and 18 in the pressing station 28 and/or in the area immediately before. The result here is that the punches 16 and 18 are accelerated to the rated speed of the rotor 12 due to the rotation of the rotor 12 but, however, as a result of inadequate surface-to-surface contact at the pressure rollers 30, these are not accelerated to their rated speed. If, in this non-normal operating condition, a first punch couple – of the punches 16 and 18 – with a normally filled matrix 14 hits the pressure rollers 30, there is a substantial difference between the momentary speeds of the rotor 12 and of the pressure rollers 30, respectively.

Whereas the rotor 12 is already accelerated to its rated speed $n_{r\text{-rated}}$, the pressure rollers 30 only have an actual speed $n_{d\text{-actual}}$ that is far below their rated speed $n_{r\text{-rated}}$. The result here is that the punches 16 and 18 have an impact on the peripheral surfaces 38 of the pressure rollers 30 with great acceleration so that, in consequence, considerable kinetic energy has to be absorbed. This can lead to mechanical damage both on the surfaces 38 of the pressure rollers 30 as well as on the punches 16 and 18, respectively.

In order to prevent this mechanical stress, the following is envisaged:

The pressure rollers 30 are provided in the known manner with measuring data probes 40, with which the momentary pressing force PK is measured. The invention is elucidated further with the schematic illustration in Figure 2.

Figure 2 shows the rotor 12 drivable by the electric drive unit 24 as well as the pressure rollers 30 allocated to the rotor 12. The punches are not shown for reasons of clarity. A control unit 42 is allocated to the rotary tablet forming machine 10, and this control unit can take over a large number of control and regulation functions. Finally, only the configuration and function of the control unit 42 as essential for the invention are described.

The control unit 42 is connected to the pressing force probes 40 by way of a signal line 44 and receives a signal pk_{actual} proportionate to the actual pressing force pk_{actual} .

The control unit 42 is also connected to the electric drive unit 24 by way of a signal line 46, by way of which the electric drive unit 24 receives a control signal n_r that corresponds to the required speed of the rotor 12 which is to be set.

The control unit 42 includes an arithmetic-logic unit 48, to which the signal pk_{actual} and a signal $pk_{required}$ from a memory facility 50 are sent, corresponding to the required pressing force $pk_{required}$ at the pressure rollers 30.

In accordance with the schematic illustrated in Figure 3, the following signal processing is effected.

In a step 52, the actual-signals pk_{actual} sent from the pressing force probes and the required-signal $pk_{required}$ sent from the memory facility 50 are processed. In this case, the difference between the signal $pk_{required}$ and the signal pk_{actual} is measured. This difference signal pk_{diff} is joined up with a signal pk_{limit} in a further step 54. The signal pk_{limit} is also, for example, provided by the memory facility 50. In this case, for example, it can be variably determined as to what extent the pressing force pk_{limit} corresponding to the signal pk_{limit} can deviate from the required pressing force $pk_{required}$. This difference between the pressing force limit value and the pressing force required value can, for example, amount to 10% of the pressing force required value.

If it is now determined in step 54 that the difference between the pressing force actual value and the pressing force required value is greater than the difference between the pressing force required value and the pressing force limit value, meaning, the pressing force actual value drops below the pressing force limit value, a signal $n_{r\text{-}required}$ is generated that corresponds to a required speed n_r of the rotor 12. This required speed is less than the rated speed of the rotor 12 in normal operation. In step 56, the signal $n_{r\text{-}required}$ corresponding to the required speed is joined up with a signal $n_{r\text{-}actual}$ corresponding to the actual speed of the rotor 12. Corresponding to a deviation between actual speed and required speed of the rotor 12, the speed signal n_r is generated and made available to the drive unit 24. This then accelerates the rotor 12 to the pre-specified speed n_r .

Based on the explanatory statements given above, it is clear that a speed control of the rotor 12 is effected in dependence of the pressing force. In this way it is achieved that, with an assumed lesser pressing force pk than the required pressing force $pk_{required}$, the rotor does not rotate at its rated speed. Particularly in the case as explained here, that the matrixes 14 are not or are only partially filled with press mass 26, the result is that the rotor 12 rotates at a pre-specifiable minimum speed n_r . In this way it is avoided that, upon first impact of lower punch 16 and upper punch 18 of an orderly filled matrix 14, these have an impact on the pressure rollers 30 with the rated speed of the rotor 12. Subsequently, the mechanical stress at this point of time is considerably reduced.

If the punches 16 and 18 of an orderly filled matrix 14 hit the pressure rollers 30, this leads automatically to an increase of the pressing force pk which is measured as actual-pressing force pk_{actual} via the pressing force probes 40. In this way, the difference between the actual pressing force and the required pressing force is reduced so that, according to the schematic as illustrated in Figure 2 and Figure 3, the speed of the rotor 12 is increased until this reaches its rated speed.

The solution according to the invention is also suitable for recognising with a rotor 12, rotating at rated speed, if the filling degree of the matrixes 14 with the press mass declines. With a reduction of the filling degree with the press mass 26, the pressing force pk drops at the pressure rollers 30 due to the direct correlations. According to the course as illustrated in Figure 3, this lowering of the actual pressing force also leads to a reduction of the required speed n_r of the rotor 12. In this case and in accordance with different embodiment variants, either an incremental or continuous reduction of the required speed n_r can be envisaged. In this way, for example, the required speed n_r can be reduced straight away to a pre-specifiable minimum speed n_{r-min} or in interim steps from the rated speed $n_{r-rated}$ to the minimum speed n_{r-min} .

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and

scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Referenced Parts List

10	Rotary tablet forming machine
12	Rotor
14	Matrix
16	Lower punch
18	Upper punch
20	Guide curve
22	Guide curve
24	Electric drive unit
26	Press mass
28	Press station
30	Pressure rollers
32	Rotary axis
34	Arrow direction
36	Movement direction
38	Peripheral surface
40	Measuring data probe
42	Signal line
44	Signal line
46	Signal line
48	Arithmetic-logic unit
50	Memory facility
52	Step
54	Step
56	Step

PK	Pressing force
$PK_{required}$	Required pressing force
PK_{actual}	Actual pressing force
PK_{limit}	Pressing force – limit value
n_d	Speed of the pressure rollers
$n_{d\text{-}rated}$	Rated speed
$n_{d\text{-}actual}$	Actual speed
n_r	Speed of the rotor
$n_{r\text{-}min}$	Minimum speed
$n_{r\text{-}rated}$	Rated speed
pk_{actual}	Proportionate signal
$pk_{required}$	Required signal
n_r	Control signal
$n_{r\text{-}required}$	Signal
$n_{r\text{-}actual}$	Signal
pk_{diff}	Difference signal